

A net volume equation for northeastern Minn

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A NET VOLUME EQUATION FOR NORTHEASTERN MINNESOTA

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A net merchantable tree volume equation and coefficients were developed for the Aspen-Birch Unit of northeastern Minnesota as part of the 1977 Minnesota Forest Inventory (fig. 1). The equation is suitable for use on digital computers by foresters, land managers, researchers, and others in need of net volume-per-tree estimates over large forest areas. Both board foot and cubic foot volume can be estimated for most tree classes.

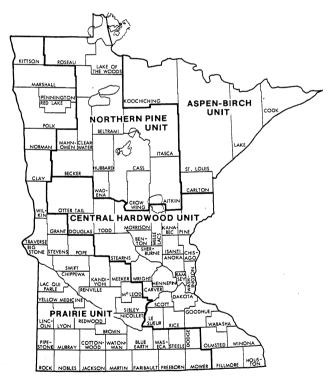


Figure 1.—Forest Inventory Units for Minnesota.

HOW THE EQUATION AND COEFFICIENTS WERE DEVELOPED

Equations developed by Robert N. Stone (see Appendix) based on Gevorkiantz and Olsen's (1955)

composite volume tables for the Lake States were used to estimate the cubic foot volume in each tree. Stone's equations computed gross volume in a tree from the three measurements—diameter breast height (d.b.h.), merchantable height, and diameter outside bark at merchantable height (t.d.o.b.). This estimated volume was then corrected for differences in bark thickness between species and the field estimate of cull volume was subtracted to arrive at net volume (see Appendix for Stone's equation).

Experience in working with volume-d.b.h. relations suggests the following equation for this type of data (Hahn 1975, 1976):

$$V = A \cdot SI \cdot (1 - e^{-B \cdot DBH})^C$$

Where the dependent variable V is net volume of the tree, and the independent variables SI and DBH are plot site index and diameter at breast height, respectively. The value of e is the constant base of the natural logarithm (2.71828). A, B, and C are the equation coefficients. The upper asympote, A•SI, is a function of site index.

The equation coefficients were developed using data collected by field crews on 18,158 trees in the Aspen-Birch Unit. Data included d.b.h., merchantable height, t.d.o.b., site index, and tree class. For sawtimber-size trees, measurements were taken at both the sawtimber and pulpwood limits of merchantability. Field crews also estimated the volume of board foot and cubic foot cull in each tree (USDA Forest Service 1975).

¹The pulpwood merchantability limits include trees 5 inches d.b.h. and over, from a 1-foot stump to a minimum of 4-inch t.d.o.b., or to the point where the central stem breaks into limbs. Dimensions for sawtimber are 9-inch d.b.h. to a minimum 7-inch t.d.o.b. and 11-inch d.b.h. to a minimum 9-inch t.d.o.b. for softwoods and hardwoods, respectively (USDA Forest Service 1975).

Equation coefficients were developed for each of five tree classes: "desirable," "acceptable," "rough," "rotten," and "short-log" (see Appendix). Equation coefficients were also developed for board foot² and cubic foot volume (79 cubic feet per cord).

The groupings of species for the equations were primarily determined by the number of observations and the similarity of bole form among species. Species for which no observations were available were assigned equations on the basis of bole form. (For species and group numbers see Appendix.)

A computerized nonlinear regression program was used to fit the above equation to the tree data. The resulting coefficients and statistics for each regression are given in tables 1-10. Note the standard error is the standard error of the regression.

Since the average site index may be used when site index is unknown, the only data needed to determine tree volumes using this model are species, d.b.h., and tree class. Most trees in Minnesota are classed as "acceptable," with very few "desirable" trees; therefore, the person wishing to use only one equation for woods-run material should use the equation for "acceptable" trees. Net volume per tree is highly variable therefore these equations should be applied to an adequate sample over large forest areas.

HOW TO USE THE EQUATION

- 1. Obtain the species group number from the Appendix.
- 2. Select the appropriate coefficients from tables 1-10.
- 3. Use these coefficients in the above equation.

LITERATURE CITED

- Gevorkiantz, S. R., and L. R. Olsen. 1955. Composite volume tables for timber and their application in the Lake States. Lake States Technical Bulletin 1104, 51 p.
- Hahn, Jerold T. 1975. Local net volume equations for Missouri. U.S. Department of Agriculture Forest Service, General Technical Report NC-15, 8 p. U.S. Department of Agriculture Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota.
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APPENDIX

METRIC EQUIVALENTS

1,000 board feet = 3.48 cubic meters.

Breast height = 1.37 meters above the ground.

1 cubic foot = 0.0283 cubic meter.

1 foot = 30.48 centimeters or 0.3048 meter.

1 inch = 25.4 millimeters or 2.54 centimeters or

0.0254 meter.

VOLUME EQUATIONS

Stone's cubic foot volume equation uses the following independent variables: diameter at breast height (D), merchantable height (H), and diameter outside bark at merchantable height (T) to estimate cubic foot volume (CV).

$$CV = (3.0886 \times 10^{-3} + S1 + S2 + S3 + S4 + S5 + S6 + S7 + S8) \cdot 79.0$$

where

$$\begin{array}{lll} \mathrm{S1} &=& (2.0355 \times 10^{-3})\mathrm{D} \\ \mathrm{S2} &=& (-3.0018 \times 10^{-3})\mathrm{T} \\ \mathrm{S3} &=& (6.2381 \times 10^{-5})\mathrm{D}^2 \\ \mathrm{S4} &=& (2.5705 \times 10^{-5})\mathrm{D}^2 \cdot \mathrm{H} \\ \mathrm{S5} &=& (-7.009 \times 10^{-6})\mathrm{H}^2 \\ \mathrm{S6} &=& (3.6708 \times 10^{-5})\mathrm{H} \cdot \mathrm{T}^2 \\ \mathrm{S7} &=& (8.14 \times 10^{-10})\mathrm{D}^2 \cdot \mathrm{H}^3 \\ \mathrm{S8} &=& (-1.9 \times 10^{-9})\mathrm{D}^2 \cdot \mathrm{H}^2 \cdot \mathrm{T} \end{array}$$

Stone's board foot volume equation as modified by Hahn (1975, 1976) is as follows:

$$BV = 17.7488 + 7.3846 \cdot CV - 2.3523 \cdot D - 0.89945 \cdot H + 2.0726 \cdot T$$

where

BV = board foot volume.

DEFINITION OF TERMS

(USDA Forest Service 1975)

Desirable trees.—Live trees that have no serious defects that limit present or prospective use and that have relatively high vigor and contain no pathogens that may result in death or serious deterioration before rotation age. They would be favored by forest managers in silvicultural operations.

Acceptable trees.—Live trees having no serious defects that limit present or prospective use but that have pathogens or damage that may affect quality.

Rough trees.—Live trees that do not contain at least one merchantable 12-foot saw log, now or prospectively, because of roughness, poor form, or noncommercial species.

Rotten trees.—"Rough" trees in which more than 50 percent of the cull volume is rotten.

Short-log trees.—Live sawtimber sized trees that contain at least one merchantable 8- to 11-foot saw log but not a 12-foot saw log, now or prospectively.

SPECIES AND SPECIES GROUPS FOR MINNESOTA TREES

Number SOFTWOODS	Species or species group	Scientific name
1	White pine	Pinus strobus
2	Red pine	Pinus resinosa
3	Jack pine	Pinus banksiana
4	White spruce	Picea glauca
5	Black spruce	Picea mariana
6	Balsam fir	Abies balsamea var. balsamea
7	Tamarack	Larix laricina
8	Northern white-cedar	Thuja occidentalis
9	Other softwoods	Pinus sylvestris
		Juniperus virginiana
HARDWOODS 10	White oak	Quaraus alba
10	wille oak	Quercus alba Quercus bicolor
11	Select red oak	Quercus macrocarpa Quercus rubra
12	Other red oak	Quercus ellipsoidalis
13	Hickory	Carya cordiformis
10	THOROTY	Carya ovata
14	Yellow birch	Betula alleghaniensis
15	Hard maple	Acer nigrum
	Tara mapro	Acer saccharum
16	Soft maple	Acer rubrum var.
		Acer saccharinum
17	Ash	Fraxinus americana
		Fraxinus niara
		Fraxinus
18		Populus
19	Paper birch	Be [†]
20 21 22		
23	Enn.	
		Ulmus rubra
0.4	Calaat handaada	Ulmus thomasii
24	Select hardwoods	Juglans cinerea
		Juglans nigra Prunus serotina
25	Other hardwoods	Acer negundo
23	Other Hardwoods	
		Betula nigra Celtis occidentalis
		Populus deltoides
		Salix nigra
26	Noncommercial species	Thur Ingia
	and a constraint section of	

Table 1.—Net cubic foot volume regression coefficients for desirable trees, Aspen-Birch Unit, Minnesota, 1977

Species group number	Co	Average			Number	Standard		
	A	В	C	- Site index	Site index	D.b.h.	observa- tions	error (cu. ft.)
1-3(9) ¹	2.154 x 10 ³	0.00651	3.52	53.5	22-80	5.2-32.0	37	19.8
1-3(9) ¹ 5(4) ¹	$6.400 \times 10^{1}_{-1}$.00460	1.78	37.6	25-86	5.0-18.6	32	2.8
6-8 14,16,17,19,22,23,	9.152 x 10 ⁻¹	.24112	11.45	46.4	16-82	5.2-20.4	36	3.3
$(10-13, 15,24,25)^1$	$8.300 \times 10^{1}_{2}$.00830	2.44	57.0	25-95	5.0-22.0	102	3.6
18,20,21	4.177×10^{2}	.00492	2.59	68.7	29-98	5.2-19.7	218	3.4

¹Data were not available for species groups in parentheses.

Table 2.—Net cubic foot volume regression coefficients for acceptable trees, Aspen-Birch Unit, Minnesota, 1977

	Willinesota, 1011						
Co	efficient		Average		e of data	Number	Standard
A	В	C	- Site index	Site index	D.b.h.	observa- tions	error (cu. ft.)
2.897 x 10 ⁹	0.00005	3.13	52.6	22-99	5.2-35.9	197	28.1
			55.7	37-75	5.0-23.0	249	4.9
			56.9	26-80	5.0-18.1	330	2.8
		2.38	57.1	22-91	5.0-25.0	321	6.8
2.036 x 10 ⁶		2.61	39.3	16-86	5.0-19.8	1,479	3.1
				18-98	5.0-19.8	2,163	2.0
		4.06	38.9	16-75	5.0-15.1	571	1.9
11	.09093	4.29	33.7	16-89	5.0-25.7	603	4.4
	.01262	2.88	59.0	36-81	5.0-15.8	41	1.8
		2.27	59.0	19-99	5.0-23.0	1,912	2.8
				46-99	5.0-18.4	162	1.6
		2.73	60.2	35-91	5.0-15.2	152	1.6
		2.44	52.0	18-99	5.0-23.6	603	3.1
		2.30	64.9	26-99	5.0-23.0	897	2.8
5.328 x 10 ⁵	.00031	2.63	63.2	35-91	5.0-22.8	131	4.2
	.00020	2.23	66.6	23-99	5.0-24.9	3,478	3.3
			59.2	36-99	5.0-20.2	131	3.2
6.920 x 10 ⁴	.00052	2.50	59.1	40-98	5.1-24.0	155	6.1
	2.897 x 10 ⁹ 1.665 x 10 ³ 3.747 x 10 ³ 1.421 x 10 ⁶ 2.036 x 10 ⁶ 2.422 x 10 ⁶ 1.304 x 10 ⁰ 1.664 x 10 ¹ 6.232 x 10 ⁵ 1.366 x 10 ⁵ 1.366 x 10 ⁶ 7.996 x 10 ⁵ 3.122 x 10 ³ 5.663 x 10 ⁵ 5.328 x 10 ⁵ 1.617 x 10 ³ 1.790 x 10 ⁴	Coefficient A B 2.897 x 10 ⁹ 0.00005 1.665 x 10 ³ .09460 3.747 x 10 ³ .00133 1.421 x 10 ⁶ .00233 2.036 x 10 ⁵ .00023 2.422 x 10 ⁵ .00026 1.304 x 10 ⁰ .10503 1.664 x 10 ¹ .01262 1.874 x 10 ⁵ .00021 1.366 x 10 ⁶ .00019 7.996 x 10 ⁶ .00019 7.996 x 10 ⁶ .00014 3.122 x 10 ³ .00026 5.663 x 10 ⁵ .00021 5.328 x 10 ⁵ .00031 1.617 x 10 ³ .00020 1.790 x 10 ⁴ .00170	Coefficient A B C 2.897 x 10 ⁹ 0.00005 3.13 1.665 x 10 ³ .09460 4.23 3.747 x 10 ³ .00133 2.31 1.421 x 10 ⁶ .0023 2.61 2.422 x 10 ⁶ .00023 2.61 2.422 x 10 ⁶ .00026 2.40 1.304 x 10 ⁰ .10503 4.06 1.664 x 10 ¹ .09093 4.29 6.232 x 10 ¹ .01262 2.88 1.874 x 10 ⁵ .00021 2.27 1.366 x 10 ⁵ .00019 2.21 7.996 x 10 ⁵ .00014 2.73 3.122 x 10 ³ .00102 2.30 5.328 x 10 ⁵ .00031 2.63 1.617 x 10 ³ .00020 2.23 1.790 x 10 ⁴ .00170 2.30	Coefficient Average Site index A B C index 2.897 x 1000005 0.00005 3.13 52.6 1.665 x 10000000 0.09460 4.23 55.7 3.747 x 1000000000 0.00133 2.31 56.9 1.421 x 10000000000000000000000000000000000	Coefficient Average index Range site index A B C index 2.897 x 109 1.665 x 100 1.665 1.669 1.669 1.669 1.669 1.669 1.669 1.669 1.669 1.669 1.669 1.669 1.669 1.669 1.669 1.669 1.669 1.669 1.669 1.669 1.669 1.660 1.669 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660 1.660	A B C index Index D.b.h. 2.897 x 100000000000000000000000000000000000	Coefficient Average index Range of data site index Number observations 2.897 x 1000

¹Data were not available for species groups in parentheses.

Table 3.—Net cubic foot volume regression coefficients for rough and short-log trees, Aspen-Birch Unit, Minnesota, 1977

	Co	Average		e of data	Number	Standard		
Species group number	Α	В	C	Site index	Site index	D.b.h.	observa- tions	error (cu. ft.)
1-3,9	2.193 x 10 ³	0.00133	2.23	54.8	33-75	5.1-18.5	52	2.6
4,5	5.289×10^{-1}	.14938	4.67	39.7	20-78	5.0-13.4	63	1.8
6	6.705×10^{-1}	.08917	3.03	52.6	19-82	5.0-16.2	135	1.7
7	7.936×10^{-1}	.09784	2.96	40.7	19-68	5.0-16.7	47	2.6
8	8.175 x 10 ⁻¹	.12157	5.24	36.3	16-98	5.0-19.0	209	4.0
11,15,24-26	ن د							
$(10,12,13)^{1}$	9.267 x 10 ⁻¹ 6.964 x 10 ⁻¹	.11819	5.80	58.0	38-77	5.0-21.9	84	1.7
14,19	6.964×10^{-1}	.13971	5.68	57.9	21-99	5.0-22.3	276	2.9
16	7 831 x 10 ⁻¹	.12297	5.74	61.2	38-87	5.0-20.6	92	1.7
17	1.636 x 10 ⁰	.10525	6.01	48.0	29-75	5.0-13.6	61	1.7
18,20,21	6.407×10^{-1}	.13405	5.60	65.6	29-99	5.0-23.7	463	3.4
22,23	6.199 x 10 ⁰	.06672	6.82	54.8	40-85	5.0-40.2	44	5.2

¹Data were not available for species groups in parentheses.

Table 4.—Net cubic foot volume regression coefficients for rotten trees, Aspen-Birch Unit, Minnesota, 1977

	Co	Coefficient				of data	Number	Standard
Species group number	A	В	С	Site index	Site index	D.b.h.	observa- tions	error (cu. ft.)
1,3-5(2,9) ¹	3.084 x 10 ⁰ 5.590 x 10 ⁻¹	0.05940	5.30	43.2	22-70	5.2-21.4	31	4.5
6,7	5.590×10^{-1}	.10190	4.76	49.0	18-70	5.0-14.7	79	3.4
8	4.386×10^{-1}	.07417	3.52	37.2	16-98	5.0-27.3	270	4.6
10,11,15,24,25								
$(12,13,26)^1$	2.458×10^{0}	.05138	6.01	55.5	36-77	5.1-25.3	98	8.0
14	$1.502 \times 10_0^{-1}$.10573	6.31	55.6	25-75	5.8-28.1	55	7.1
16	$6.660 \times 10^{\circ}$.04680	5.61	58.0	38-87	5.0-21.8	1,142	4.3
17	7.845×10^{-2}	.19333	4.04	48.4	25-82	5.0-22.9	46	4.2
18,20,21	4.962×10^{-1}	.03528	1.73	63.7	29-99	5.0-28.9	694	6.9
19	1.606×10^{-1}	.17045	5.80	51.1	22-83	5.0-27.5	171	5.7
22,23	1.445 x 10 ⁻¹	.18231	5.94	56.1	35-82	5.1-34.4	46	7.5

¹Data were not available for species groups in parentheses.

Table 5.—Net board foot 1 volume regression coefficients for desirable trees, Aspen-Birch Unit, Minnesota, 1977

Species group number	Co	Average	Range of data		Number	Standard		
	A	В	С	- Site index	Site index	D.b.h.	observa- tions	error (bd. ft.)
1-3,5,7,8(4,6,9) ² 14,16,17,19,22,23	3.643 x 10 ⁵	0.00087	2.61	49.7	16-86	9.6-32.0	50	165.5
(10,13,15,24,25) ² 18,20,21	2.046 x 10 ³ 2.064 x 10 ³	.00336 .00337	2.23 2.24	57.8 68.7	25-82 36-98	11.2-22.0 11.0-19.7	40 76	41.9 34.7

¹International 1/4-inch rule.

Table 6.—Net board foot 1 volume regression coefficients for acceptable trees, Aspen-Birch Unit, Minnesota, 1977

.	· Co	Coefficient				e of data	Number	Standard
Species group number	A	В	C	- Site index	Site index	D.b.h.	observa- tions	error (bd. ft.)
1	8.873×10^4	0.00130	2.62	52.6	22-99	9.3-35.9	178	207.3
2	1.614×10^{4}	.00054	1.80	54.4	37-75	9.1-23.0	162	36.5
$3(9)^2$	5.018×10^{3}	.00261	2.40	58.1	33-80	9.1-18.1	163	21.6
4	2.379×10^{6}	.00060	2.96	57.3	22-91	9.0-25.0	210	47.8
5	3.544×10^{6}	.00069	3.03	44.0	16-86	9.0-19.8	195	39.7
6,7	3.989×10^{3}	.00233	2.26	56.3	16-88	9.0-19.8	554	20.5
F 40	3.869 x 10 ³	.00251	2.21	34.7	16-89	9.0-25.7	680	39.7
			1.80	58.5	43-82	11.0-18.4	53	24.6
			1.68	57.4	19-99	11.0-23.0	253	39.6
			1.65	50.1	21-99	11.0-23.6	99	48.2
			2.08	64.5	26-98	11.0-23.0	251	33.5
			2.43	68.1	23-99	11.0-24.9	1,009	40.1
			2.35	58.3	40-83	11.0-20.2	38	45.5
			2.63	56.6	40-84	11.0-24.0	94	51.0

²Data were not available for species groups in parentheses.

Table 7.—Net board foot¹ volume regression coefficients for short-log trees, Aspen-Birch Unit, Minnesota, 1977

Species group number	Co	Average			Number	Standard		
	Α	В	C	- Site index	Site index	D.b.h.	observa- tions	error (bd. ft.)
$1-7(9)^2$	5.502 x 10 ⁻¹	0.10168	4.93	52.6	35-82	9.0-16.7	50	37.5
8	5.502 x 10 ⁻¹ 2.445 x 10 ⁰	.06232	1.71	38.9	20-98	9.0-19.0	55	29.6
11,14,16,17,19,22,23 (10,12,13,15,24-26) ²	1.846 x 10 ¹ 2.963 x 10 ⁵	.05735	5.02	57.6	38-83	11.0-40.2	41	40.1
18,20,21	2.963 x 10 ⁵	.00014	2.06	67.7	36-99	11.1-20.0	70	31.1

Table 8.—Net cubic foot volume in saw log regression coefficients for desirable trees, Aspen-Birch Unit, Minnesota, 1977

Species group number	C	Average			Number	Standard		
	A	В	C	- Site index	Site index	D.b.h.	observa- tions	error (cu. ft.)
1-3,5,7,8 (4,6,9) ¹ 14,16,17,19,22,23	1.056 x 10 ⁴	0.00148	2.53	49.7	16-86	9.6-32.0	50	23.9
(10-13,15,24,25) ¹ 18,20,21	2.200 x 10 ³ 3.049 x 10 ³	.00158 .00185	2.31 2.49	57.8 68.7	25-82 36-98	11.2-22.0 11.0-19.7	40 76	6.3 5.5

¹Data were not available for species groups in parentheses.

¹International ¼-inch rule.
²Data were not available for species groups in parentheses.

Table 9.—Net cubic foot volume in saw log regression coefficients for acceptable trees, Aspen-Birch Unit, Minnesota, 1977

	Co	efficient		Average		e of data	Number	Standard
Species group number	A	В	C	Site index	Site index	D.b.h.	observa- tions	error (cu. ft.)
1	3.472×10^3	0.00191	2.50	52.6	22-99	9.3-35.9	178	29.7
2	4.255×10^{3}	.00028	1.66	54.4	37-75	9.1-23.0	162	6.1
3(9) ¹	2.275×10^{3}	.00170	2.38	58.1	33-80	9.1-18.1	163	3.7
4	1.550×10^{3}	.00064	1.78	57.3	22-91	9.0-25.0	210	8.2
5	1.663×10^{3}	.00149	2.14	44.0	16-86	9.0-19.8	195	7.2
6,7	1.756×10^{3}	.00147	2.25	56.3	16-88	9.0-19.8	554	3.6
8	1.521 x 10 ³	.00141	2.10	34.7	16-89	9.0-25.7	680	6.8
10,11,15,16	5.096×10^3	00045	4 00	F0 F	40.00	44.040.4	50	0.5
$(12,13,24,25)^1$.00015	1.60	58.5	43-82	11.0-18.4	53	3.5
14,19	1.187×10^{3}	.00013	1.32	57.4	19-99	11.0-23.0	253	6.7
17	2.457×10^{3}	.00019	1.48	50.1	21-99	11.0-23.6	99	8.8
18	1.584 x 10 ³	.00015	1.40	64.5	26-98	11.0-23.0	251	6.1
20,21	3.185×10^{2}	.00303	2.20	68.1	23-99	11.0-24.9	1,009	5.9
22	2.629×10^{2}	.00284	2.10	58.3	40-83	11.0-20.2	38	6.0
23	3.435 x 10 ⁴	.00054	2.40	56.6	40-84	11.0-24.0	94	8.0

¹Data were not available for species groups in parentheses.

Table 10.—Net cubic foot volume in saw log regression coefficients for short-log trees, Aspen-Birch Unit, Minnesota, 1977

	Co	Average	Range of data		Number	Standard		
Species group number	A	В	C	- Site index	Site index	D.b.h.	observa- tions	error (cu. ft.)
1-7(9) ¹	6.107×10^{2}	0.00194	2.21	52.6	35-82	9.0-16.7	50	6.3
8 11,14,16,17,19,22,23	1.071 x 10 ²	.00146	1.59	38.9	20-98	9.0-19.0	55	6.0
$(10,12,13,15,24-26)^1$	4.456×10^{2}	.00228	2.27	57.6	38-83	11.0-40.2	41	4.4
18,20,21	5.795 x 10 ¹	.00092	1.33	67.7	36-99	11.1-20.0	70	4.9

¹Data were not available for species groups in parentheses.

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1980. A net volume equation for Northeastern Minnesota. U.S. Department of Agriculture Forest Service, General Technical Report NC-66, 8 p. U.S. Department of Agriculture Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota.

Describes a net volume equation for northeastern Minnesota developed as part of the 1977 Minnesota Forest Inventory. Equation coefficients are presented by species groupings for both cubic foot and board foot volumes for five tree classes.

KEY WORDS: inventory, computer, growing-stock, cull, cubic foot volume, board foot volume.

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